Overview of RADSAGA activities at CERN

Andrea Coronetti (EN-STI-BMI)

Indico link: https://indico.cern.ch/event/760345/

R2E Annual Meeting

DEC, 11-12TH | CERN, 774/R-013

RADSAGA

Outline

- Introduction
- CHARM Experiments
- Heavy Ions Experiments
- CNES – Ninano and 3DPlus Camera
- Pion testing at PSI
- Prospects for 2019

Introduction

- Non-qualified COTS systems
- No radiation level criterion

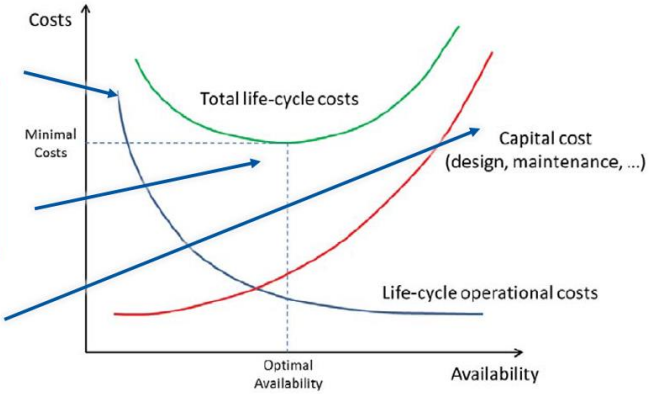
(standard ground-level applications)

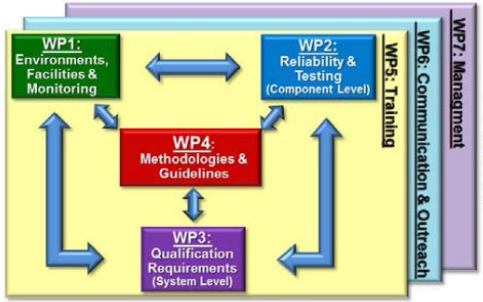
- COTS components for rad-tolerant system designs
- Rad-hard by design for critical components
- Qualification at system level, radiation environment analysis

(RADSAGA objective)

- Rad hard-components
- Heavy ion SEE qualification at component level

(critical space applications)



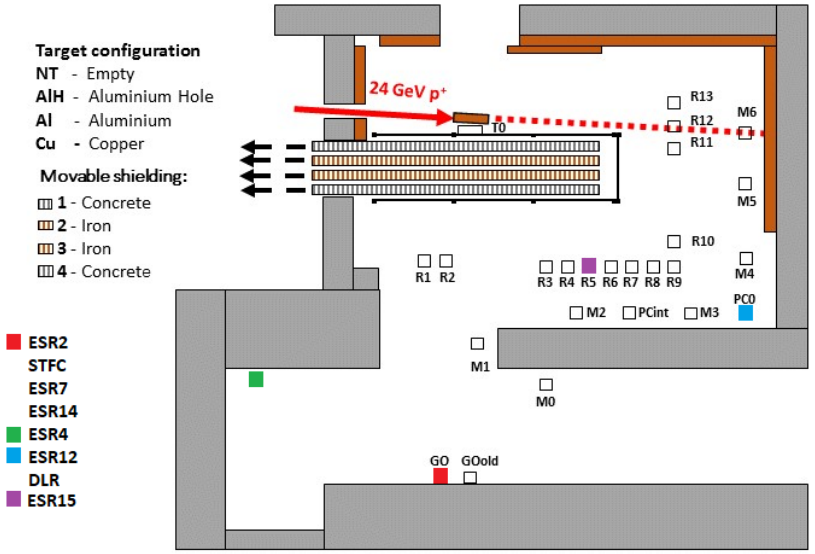


KU LEUVEN 4 · UNIVERSITE MONTPELLIER 4 · 3plusD a HEICO company 1 · 1 · JYVÄSKYLÄN YLIOPISTO UNIVERSITY OF JYVÄSKYLÄ 2 · btu 1 · CERN 2

CHARM Experiments

6 ESRs + 1 partner (CNES) + 2 associates (STFC, DLR)

- **WP1** (Environments, facilities and monitoring):
  - ESR2: Cu-doped optical fibers
  - ESR4: PIN diode Canberra
  - STFC: PIN diode
- **WP2** (Components):
  - ESR7: GaN and SiC Power MOSFETs
- **WP3** (Systems):
  - ESR12: PoL DC-DC Converter
  - ESR14: Data System Acquisition (avionics)
  - DLR: General Software Defined Radio
- **WP4** (Guidelines):
  - ESR15/CNES: Ninano + 3DPlus Camera



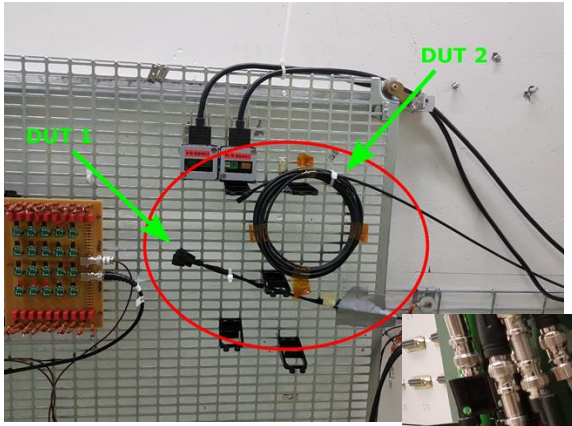
CHARM Experiments

Optical fibers

- Scope: assessment of Radioluminescence of Cu-doped fiber
- FDP used for filtering Cherenkov
- Issues during test preparation
  - Only short fibers possible
  - PMT installed underneath the patch panel
  - Signal PMT much higher than RL

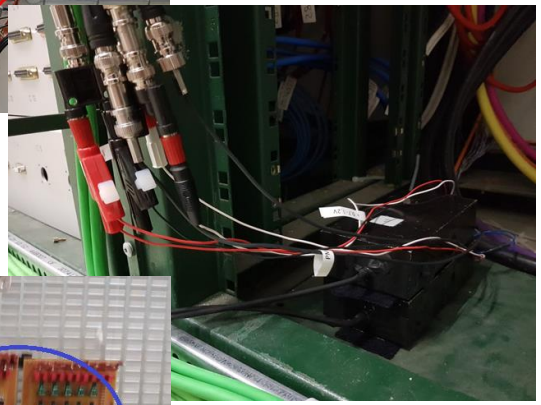
Power MOSFETs

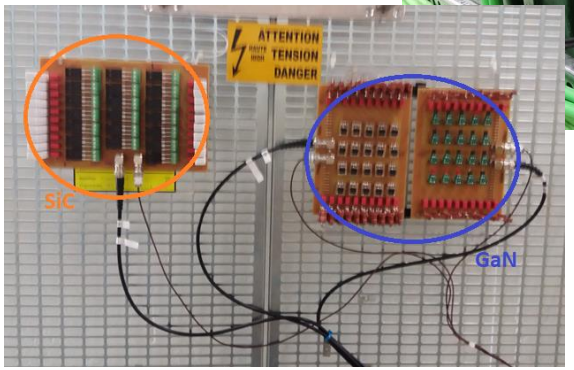
- COTS GaN and SiC :
  - Panasonic PGA26E19BA (GaN, 600 V)
  - EPC EPC2012 (GaN, 200 V)
  - CREE C3M0120090 (SiC, 900 V)
- No SEB on GaN
- SEB on SiC at 95% of max V_{DS}



DUT1: Cu-doped optical fiber
DUT2: FDP Cherenkov fiber for comparison
(Credit Daniel Soderstrom)

Photomultiplier Hamamatsu
(Credit Daniel Soderstrom)





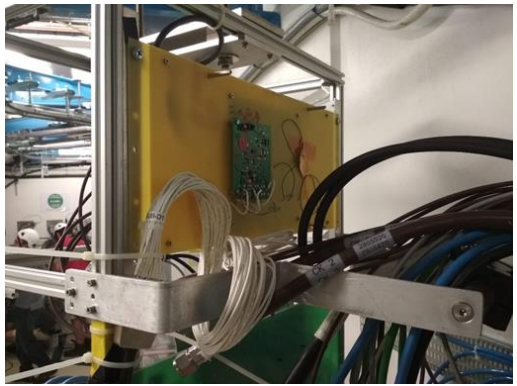
SiC and GaN Power MOSFETs

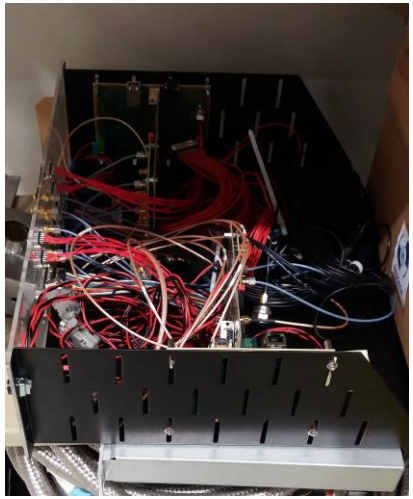
CHARM Experiments

PoL DC-DC Converter

- 2D board version of 3DPlus product
- Rad-hard space system
- First test: no SET, no SEL
- Re-iterated with less rad-tol components
- Why? Scope is assessment of SET propagation at system level
- SET seen, no SEL

2D version of 3DPlus
PoL DC-DC Converter
(Credit Tomasz Rajkowski)





DLR General Software
Defined Radio setup
2 DUTs were tested

* German Aerospace Agency

DLR* Software Defined Radio

- Main application: COM inside SAT constellation
- Digital data transmission of modulated RF signals and telemetry
- RFIC AD9361
  - No errors on RF chip
- Controlled by Zynq with Linux OS
  - Multiple errors on Zynq and FPGA resets
  - Reset operation not affected by spill (t > 20 s)
- High flux functional errors at system level
  - KVI proton test at various fluxes

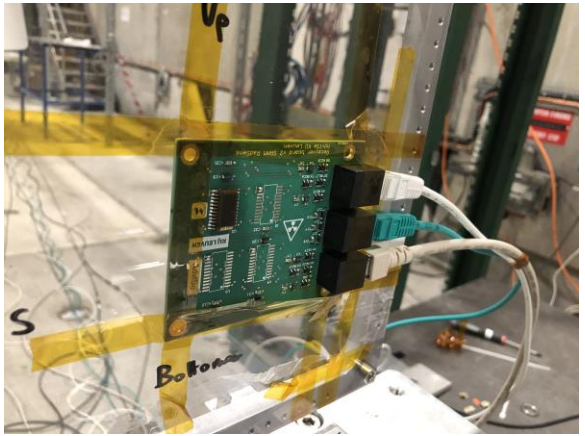
Heavy Ions Experiments

H8 North Area

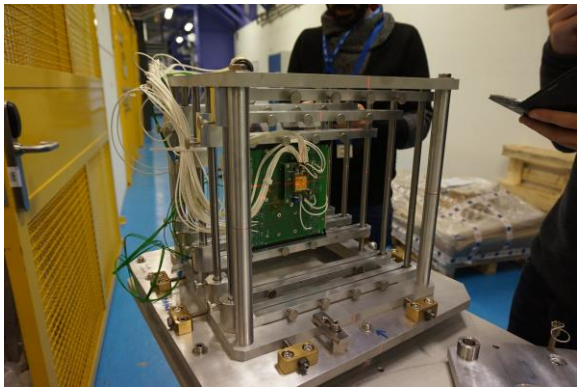
- Low flux, higher LET (9 MeV.cm²/mg)
- ESR5: SRAM-based SEU Monitor

CHARM

- High flux, lower LET (8 MeV.cm²/mg)
- ESR7: GaN and SiC Power MOSFETs
- ESR12: PoL DC-DC Converter



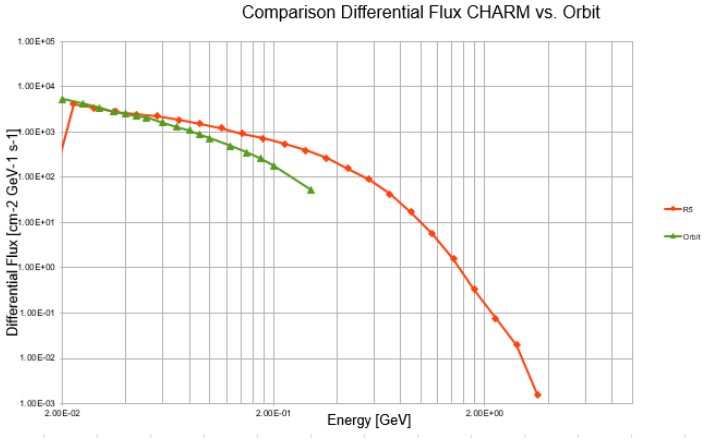
SRAM-based SEU Monitor at H8
(Credit: Jialei Wang)

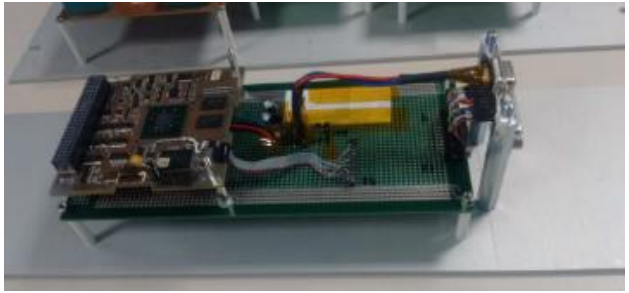


3DPlus PoL DC-DC Converter on Montrac
(Credit: Tomasz Rajkowski)

CNES – Ninano and 3DPlus Camera

- Test in R5 relevant for LEO spectra
- Test of OBC with payload
- Scope: performances of OBC and camera
- Setup issues:
  - First 2 weeks in G0
  - Last 2 weeks in R5
- Zynq still operational after 400 Gy(Si)





Ninano test board for CHARM
(Credit: CNES)

Ninano+Camera test setup for CHARM

CNES – Ninano and 3DPlus Camera

Commercial 3D module

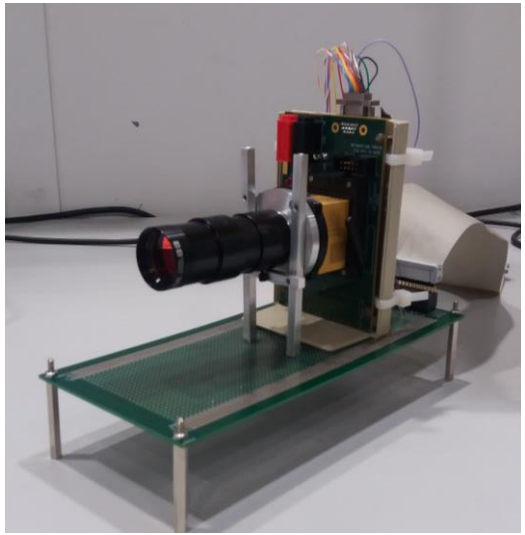
- SpaceWire COM with OBC
- 4 Mpixels (10/12 bits per pixel)
- Eyesat config, high exp time (1500 ms)

Declared radiation performances

- Rad-hard technology (TID > 400 Gy(Si))
- SEL immune up to 60 MeV.cm²/mg

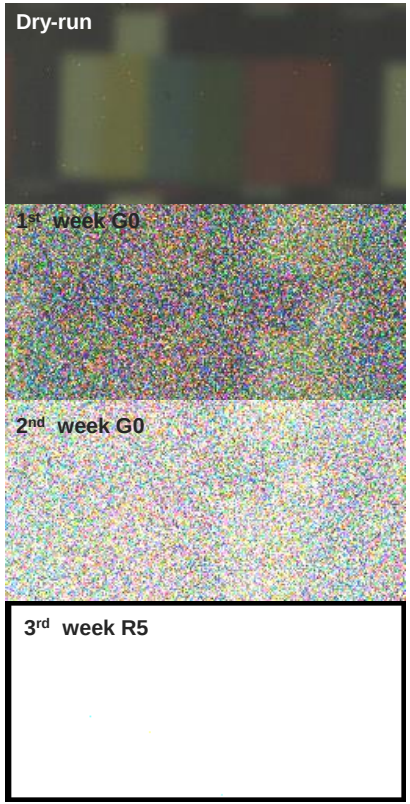
Tested radiation performances:

- Internal electronics is TID tolerant up to 500 Gy(Si) (Co-60)
- SEL seen at CHARM



3DPlus Camera and optics

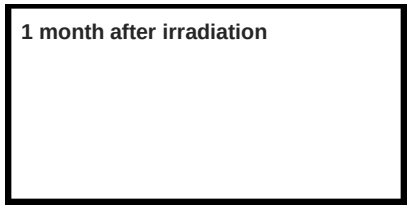
CNES – Ninano and 3DPlus Camera



- Only radiation test for real images
  - Dose ~ 400* Gy(Si)
  - 1 MeV neq fluence ~ 5E+12* cm^{-2}
  - HEH fluence ~ 7.5E+11* cm^{-2}

Data from FLUKA assuming 5E+11 POT per spill

- Many pixels saturated after 1 week in G0
- Progressive degradation in coming weeks
- Full white image
- No recovery after 1 month from irradiation
- Better performance for black image (last week)
- Unknown issue on readout electronics or CIS?



Pion testing at PSI

Motivation

- pions make for large part of mixed-field
- treated as protons for SEE qualification

πM1 beamline

- Energy ~ 51-233 MeV
- FWHM ~ 1x1 cm^2
- Max flux ~ 3e6 $cm^{-2}s^{-1}$
- π^-, π^+ available, only negative tested

DUTs tested

- SEU

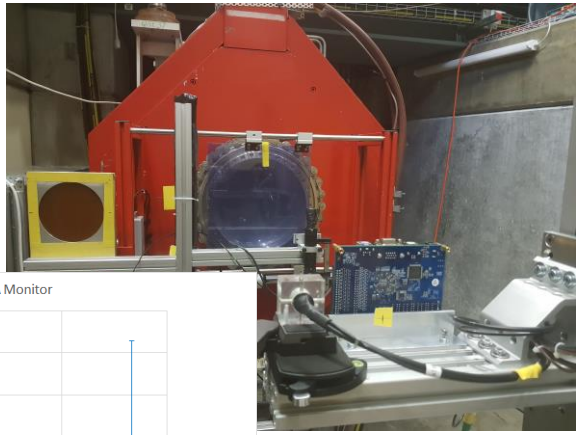
  ESA Monitor, Cypress 90 nm, Cypress 65 nm, ISSI 65 nm
- SEL

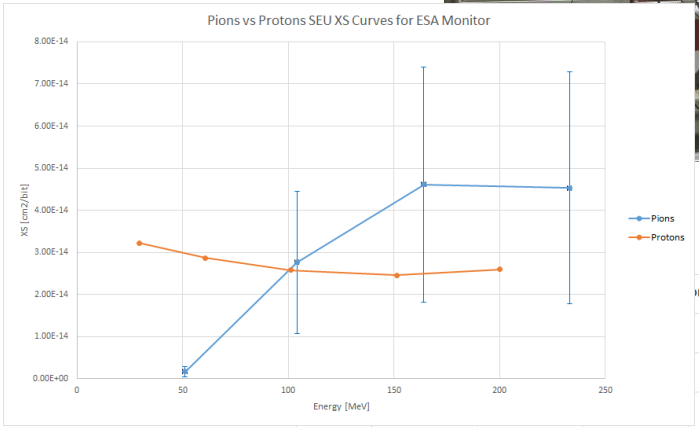
  Lyontek 180 nm, Brilliance 180 nm

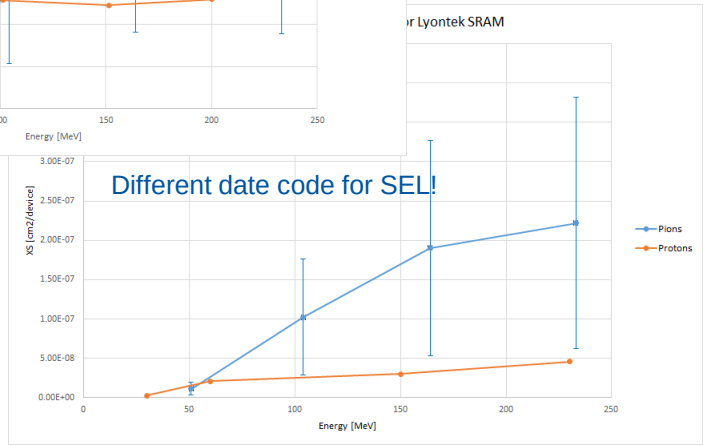
Outcome

- Resonance peak above 100 MeV (mixed-field impact?)

πM1 beamline at PSI
(Credit: Daniel Soderstrom)







Prospects for 2019

RADSAGA

- KVI-CART, high energy protons (January, ESR2, ESR5, ESR13)
- ChipIR, neutron spallation (March, ESR7, ESR13)
- GANIL, high LET heavy ions (July)
- RADEF, new 16 MeV/n heavy ions (?)
- PSI, high energy protons (?)

ESR15

- Electron DD on PIN diodes at VESPER (April)
- Guideline development
  - Facility summary
  - Wide bandgap
  - 14 MeV neutrons

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